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MacDiarmid et al.

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[54] **ELECTROCHEMICAL DOPING OF CONJUGATED POLYMERS**

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[58] **Field of Search** 429/212, 50, 213, 199; 204/131, 2.1, 291, 165

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[57] **ABSTRACT**

Conjugated polymers are doped with dopant ions to a preselected room temperature electrical conductivity ranging from that characteristic of semiconductor behavior to that characteristic of metallic behavior, by means of an electrochemical procedure wherein the polymer is employed as one or both of the electrodes of an electrolytic cell, including as the electrolyte a compound which is ionizable into the dopant ions. Upon electrolysis of the electrolyte, the polymer, if used as the anode, becomes doped with anionic dopant ions to a p-type material; or if used as the cathode, becomes doped with cationic dopant ions to an n-type material.

The above-described electrochemical doping procedure finds particularly useful application in the charging of novel secondary batteries in which a doped conjugated polymer is employed as one or both of the electrodes. Such secondary batteries, in their charged state, comprise a metal whose Pauling electronegativity value is no greater than 1.6, or a conjugated polymer doped with dopant cations of said metal, as the anode-active material; a conjugated polymer doped with dopant anions as the cathode-active material; and a compound which is ionizable into the dopant ions as the electrolyte. In the initial discharged state of such secondary batteries, the polymer is in undoped form, and charging of the battery is effected by electrochemical doping of the polymer with the dopant ions of the electrolyte.

28 Claims, No Drawings